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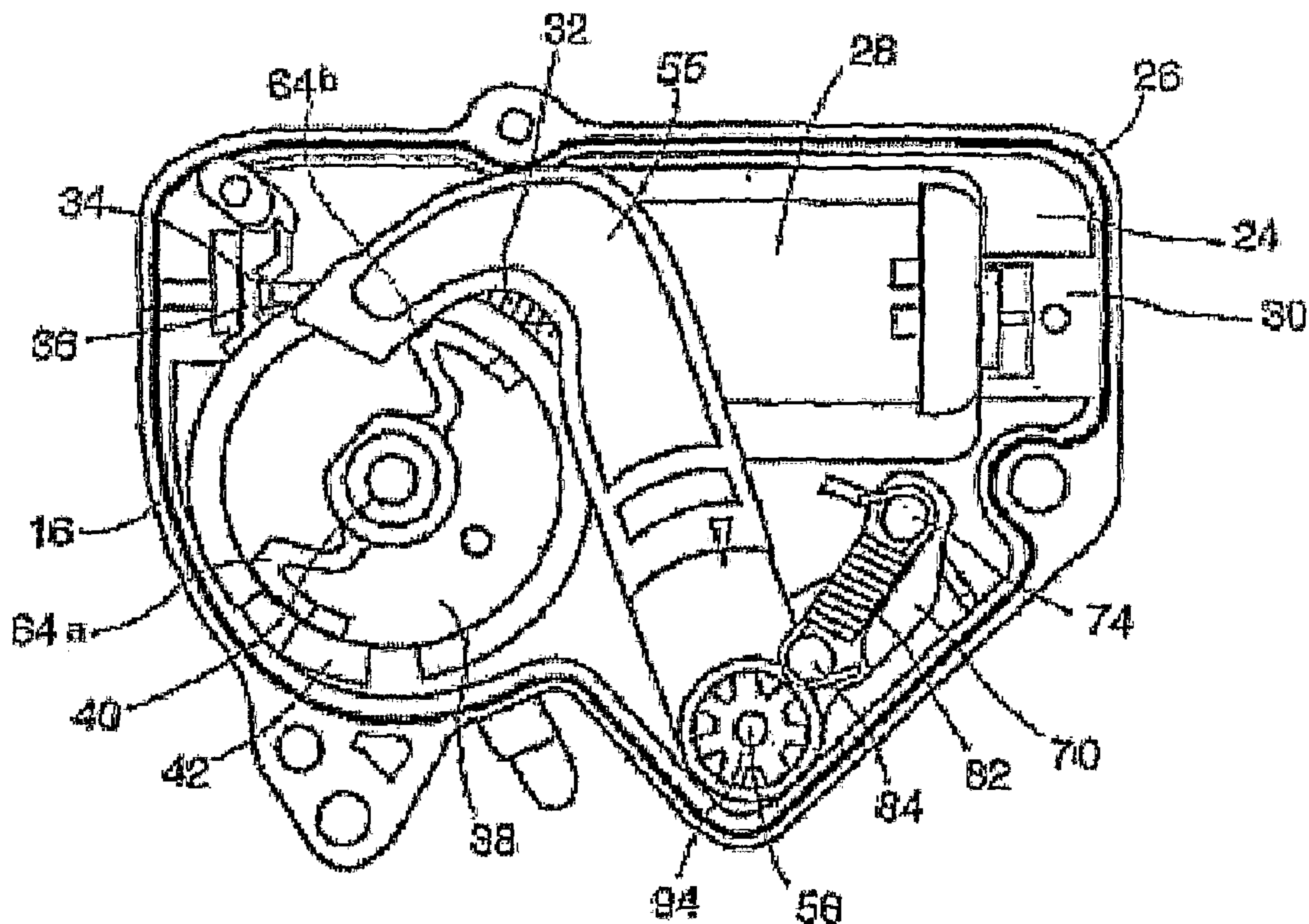
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(57) Abrégé/Abstract:

A power actuator is provided for a door latch. A transfer lever within the housing is selectively coupled to a motor-driven worm gear via a lost motion connector. Engaging the motor moves the transfer lever between a locked and an unlocked position, actuating an

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output lever mounted to a spline on the transfer lever. The worm gear returns to a neutral position when the motor is disengaged, leaving the transfer lever in either the locked or unlocked positions. Manually moving the output lever causes the transfer lever to move between its locked and unlocked positions without back-driving the worm gear. A toggle mechanism prevents the transfer lever from accidentally moving or only moving partially between the locked and unlocked positions.

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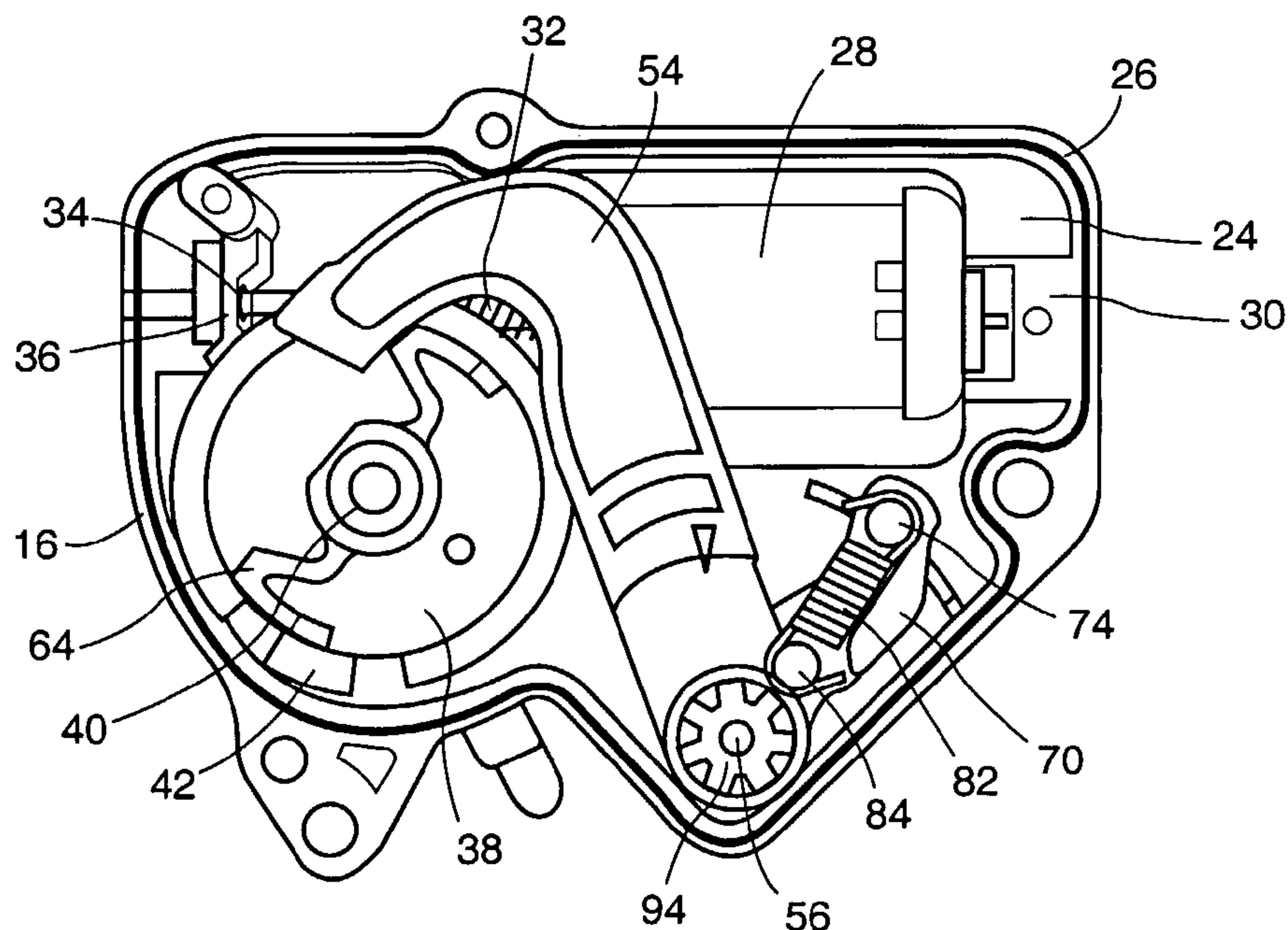
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(54) Title: POWER ACTUATOR



(57) Abstract: A power actuator is provided for a door latch. A transfer lever within the housing is selectively coupled to a motor-driven worm gear via a lost motion connector. Engaging the motor moves the transfer lever between a locked and an unlocked position, actuating an output lever mounted to a spline on the transfer lever. The worm gear returns to a neutral position when the motor is disengaged, leaving the transfer lever in either the locked or unlocked positions. Manually moving the output lever causes the transfer lever to move between its locked and unlocked positions without back-driving the worm gear. A toggle mechanism prevents the transfer lever from accidentally moving or only moving partially between the locked and unlocked positions.

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Power Actuator

Field of the Invention

The present invention relates to locking systems for motor vehicles. More
5 specifically, the present invention relates to power actuator operable to lock or unlock
a latch on a sliding side door.

Background of the Invention

Motor vehicles with sliding doors (typically vans), typically use power
10 actuators to electrically lock and unlock the sliding door. The power actuator is
typically engaged by interior door lock switches or a remote key fob, and locks or
unlocks a side door latch. Normally, the power actuator is connected to a lock lever
on the side door latch via a door lock rod. Since the door latch can be locked or
unlocked manually as well as electronically, the power actuator must also be able to
15 move between a locked and an unlocked state un-powered, and without undesirable
back drive from the power actuator's motor. Preferably, the power actuator is
modular so that it can be easily installed and/or replaced. Additionally, the power
actuator should be compact, reliable and inexpensive to manufacture.

20 It is therefore desired to provide a power actuator that locks and unlocks a side
door latch, and further, will move between a locked and an unlocked state when the
door latch is manually locked or unlocked without back-driving the power actuator's
motor. It is further desired to provide a modular power actuator that is compact,
reliable and inexpensive to manufacture.

25

Summary of the Invention

According to a first aspect of the invention, there is provided a power actuator
for a door latch. The power actuator includes a housing; a reversible motor, mounted
to the housing; a worm, driven by the motor; and a worm gear, rotatably mounted to
30 the housing and driven by the worm. The worm gear is rotatable between a first and a
second angular position upon actuation of the motor. A spring, mounted to the
housing, urges the worm gear to a neutral position intermediate the first and second

angular positions when the motor is disengaged. The power actuator further includes a transfer lever, pivotally mounted to the housing and movable between a first and second positions. The transfer lever is kinematically coupled to the worm gear via a lost motion connection, thereby enabling the transfer lever to be moved between the first and second position without driving the worm gear when the worm gear is in the neutral position. An output lever is mounted to a spline on the transfer lever. A toggle mechanism prevents the transfer lever from accidentally moving, or only moving partially between the locked and unlocked positions.

10 **Brief Description of the Drawings**

Figure 1 is a plan view of a power actuator in accordance with a first aspect of the invention;

Figure 2 is a plan view of an upper housing mounted of the power actuator shown in Fig 1;

Figure 3 is an inner plan view of the power actuator shown in Fig. 1;

Figure 4 is a partially exploded view of a drive train mounted in the power actuator of Fig. 1;

Figure 5a and 5b are fragmentary views of the power actuator shown in Figs 2-3, showing the motion of a transfer lever;

Figure 6 is a fragmentary view of the power actuator shown in Figs. 2-3, showing a locking lever; and

Figure 7 is a fragmentary view of the upper housing shown in Figs 1-2, showing an output lever.

Detailed Description of the Invention

Referring now to Figs. 1-3, a power actuator according to the preferred embodiment is shown at 10. Power actuator 10 includes a clam-shell housing 12 formed from a complementary upper housing 14 and a lower housing 16. Preferably, both upper housing 14 and lower housing 16 are formed from a rigid thermoplastic material. An integrally-formed mounting structure (not shown) is provided on the exterior surface of lower housing 16 to mount power actuator 10 to a vehicle or vehicle module (not shown). Upper housing 14 includes a substrate 20, and peripheral walls 22 extending out from substrate 20 towards lower housing 16. Lower housing 16 includes a substrate 24 and peripheral walls 26. A detent on the top of peripheral walls 22 fits within a groove provided in the top of peripheral walls 26 to provide a weather-tight seal between the two housings.

A motor 28 is mounted within a motor housing 30 formed in substrate 24 on lower housing 16. Motor 28 is a bi-directional DC motor and is operable to drive a worm 32. The shaft of worm 32 is journaled within a centering hole 34 on a support wall 36 integrally formed from substrate 24.

As can be more clearly seen in Fig. 4, worm 32 drives a worm gear 38 that is rotatably mounted to a post 40 integrally formed from substrate 24. The angular travel of worm gear 38 is delimited by a stop tab 42 abutting a first shoulder 44, or a second shoulder 46. Thus, worm gear 38 is rotatable between a first or "locking" position, where stop tab 42 abuts the first shoulder 44, and a second or "unlocking" position, where stop tab 42 abuts the second shoulder 46. A centering spring 48 with a pair of toggle arms 50 is located around post 40 between worm gear 38 and substrate 24. As worm gear 38 rotates to either of the locking or unlocking positions, a depending tab 52 engages and pushes the leading toggle arm 50. A retaining tab 54 extending out from substrate 24 impedes the rotational motion of the trailing toggle arm 50, causing the centering spring 48 to twist and thereby load the spring. When motor 28 disengages, the tension on centering spring 48 is released, so that centering spring 48 reverses the direction of worm gear 38, backdriving motor 28. Worm gear 38 returns

to a “neutral” position midway between the locking and the unlocking positions, where depending tab 52 and retaining tab 54 are aligned.

A transfer lever 55 is pivotally mounted to power actuator 10. An axial post 56
5 locates transfer lever 55 in a hole 58 in upper housing 14 (Fig. 2) and lower housing 16 (not shown). The angular motion of transfer lever 55 is delimited by a wall 60 and a wall 62, both integrally formed in upper housing 14. When transfer lever 55 abuts wall 60, it is in its “locked” position, and when transfer lever 55 abuts wall 62, it is in its “unlocked” position. Rotating worm gear 38 to the locking position actuates
10 transfer lever 55 to its locked position, and conversely, rotating worm gear 38 to the unlocking position actuates transfer lever 55 to the unlocked position. In the illustrated embodiment, worm gear 38 includes a pair of curved transfer lobes 64a and 64b extending outward from the surface of the gear towards upper housing 14. While at rest, a depending tab 66 on the end of transfer lever 55 abuts one of the transfer
15 lobes 64. As worm gear 38 rotates clockwise or counterclockwise towards either the locking or unlocking positions, the abutting transfer lobe 64 engages depending tab 66 to actuate transfer lever 55. When transfer lever 55 is in its locked position, depending tab 66 abuts transfer lobe 64a (Fig. 5a), and when transfer lever 55 is in its unlocked position, depending tab 66 abuts transfer lobe 64b (Fig. 5b). The arc of
20 travel of transfer lobes 64 is substantially similar to the arc of travel of transfer lever 55. In addition, depending tab 66 includes a pair of symmetrically curved engagement surfaces 68, so that an even transfer of torque from worm gear 38 to transfer lever 55 is maintained for both the clockwise and counterclockwise rotation of worm gear 38. As is described above, once motor 28 disengages, the recoiling of centering spring 48
25 returns worm gear 38 to its neutral position. Thus, depending tab 66 now abuts the other transfer lobe 64, so it can quickly be actuated to the other position.

A locking lever 70 acts as a toggle mechanism and reduces the possibility of transfer lever 55 pivoting accidentally. or pivoting only partially between the locked
30 and unlocked position. Referring now to Fig. 6, locking lever 70 is slidably retained within a slot 72 (Fig. 2) in substrate 20 via a post 74. Locking lever 70 is further pivotable between a “locked” and an “unlocked” position. As will be described in

greater detail below, locking lever 70 is in its locked position when transfer lever 55 is in its locked position, and conversely, locking lever 70 is in its unlocked position when transfer lever 55 is in its unlocked position. A key post 76 extending from locking lever 70, and offset from post 74 is located in a keyhole 78 on a locking arm 80 of transfer lever 55, so that rotating transfer lever 55 rotates locking lever 70 in the opposite direction. A toggle spring 82 is hooked around post 74 on locking lever 70 and a depending post 84 on locking arm 80 near axial post 56. As transfer lever 55 begins to pivot from either the locked or unlocked position to the other position, the counter-rotation of keypost 76 within keyhole 78 on locking arm 80 displaces locking lever 70 away from transfer lever 55 within slot 72. The distance between post 74 and depending post 84 increases, stretching locking toggle spring 82. Thus, toggle spring 82 provides a resisting force against the rotation of transfer lever 55. When both transfer lever 55 and locking lever 70 are midway between positions, toggle spring 82 is under maximal tension. When the two levers move past the midway point, the distance between post 74 and depending post 84 diminishes. Now, toggle spring 82 contracts, providing an assisting force urging the two levers into their destined position. As will be apparent to those of skill in the art, the strength of toggle spring 82 can be changed in order to increase or decrease the effort required to pivot transfer lever 55.

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An output lever 86 (Fig. 1) is mounted to transfer lever 55 on the exterior of upper housing 14. Referring now to Fig. 7, a star-shaped mounting hole 92 on output lever 86 locates the output lever on a complementary star-shaped spline 94 extending out from axial post 56 on transfer lever 55. In the current embodiment, spline 94 includes seven radial teeth 96. The drafted slopes on both mounting hole 92 and teeth 96 provide for the optimum distribution of torque between transfer lever 56 and output lever 86. The complementary angles of mounting hole 92 and teeth 96 increases the contact surface area of the two levers, improving the mating component to withstand more stress. A fastener 98, such as a screw or rivet, is mounted through coaxial holes on output lever 86 and spline 94, and assists in coupling output lever 86 and transfer lever 55 together. An O-ring seal 100 prevents moisture from entering power actuator 10 through hole 58.

As can be clearly seen in Fig. 1, output lever 86 includes a lock arm 102 and a latch arm 104, the two arranged in a V-shaped configuration around mounting hole 92. Lock arm 102 includes a lock loop 106 operable to retain a manual release door lock rod (not shown). Latch arm 102 includes a mounting hole 108 operable to retain a clip for a cable connected to a side door latch (not shown). Manually actuating the door lock rod causes output lever 86 to pivot around mounting hole 92, causing the cable to actuate the side door latch. Pivoting output lever 86 between first and second positions causes transfer lever 55 and locking lever 70 to pivot as well. Locking lever 70 moves between its locked and unlocked positions, thereby ensuring that output lever 86 is moved completely into its new position. Depending tab 66 on transfer lever 55 moves from abutting one transfer lobe 64 to abutting the other transfer lobes 64. Center toggle spring 58 provides a degree of lost motion in worm gear 38 so that it does not rotate. Thus, there is no backdriving of motor 28.

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Referring back to Fig. 2, an electronic or mechanical switch 110 having a “locked” and an “unlocked” state is mounted in upper housing 16. When transfer lever 55 is in its locked position, it triggers switch 110 into the locked state, and when transfer lever 55 is in its second position, it releases switch 110 into the unlocked state. State information from switch 110 is transmitted to a vehicle controller (not shown) via blades 112 (also not shown). Electrical power for motor 26 is also provided via blades 112.

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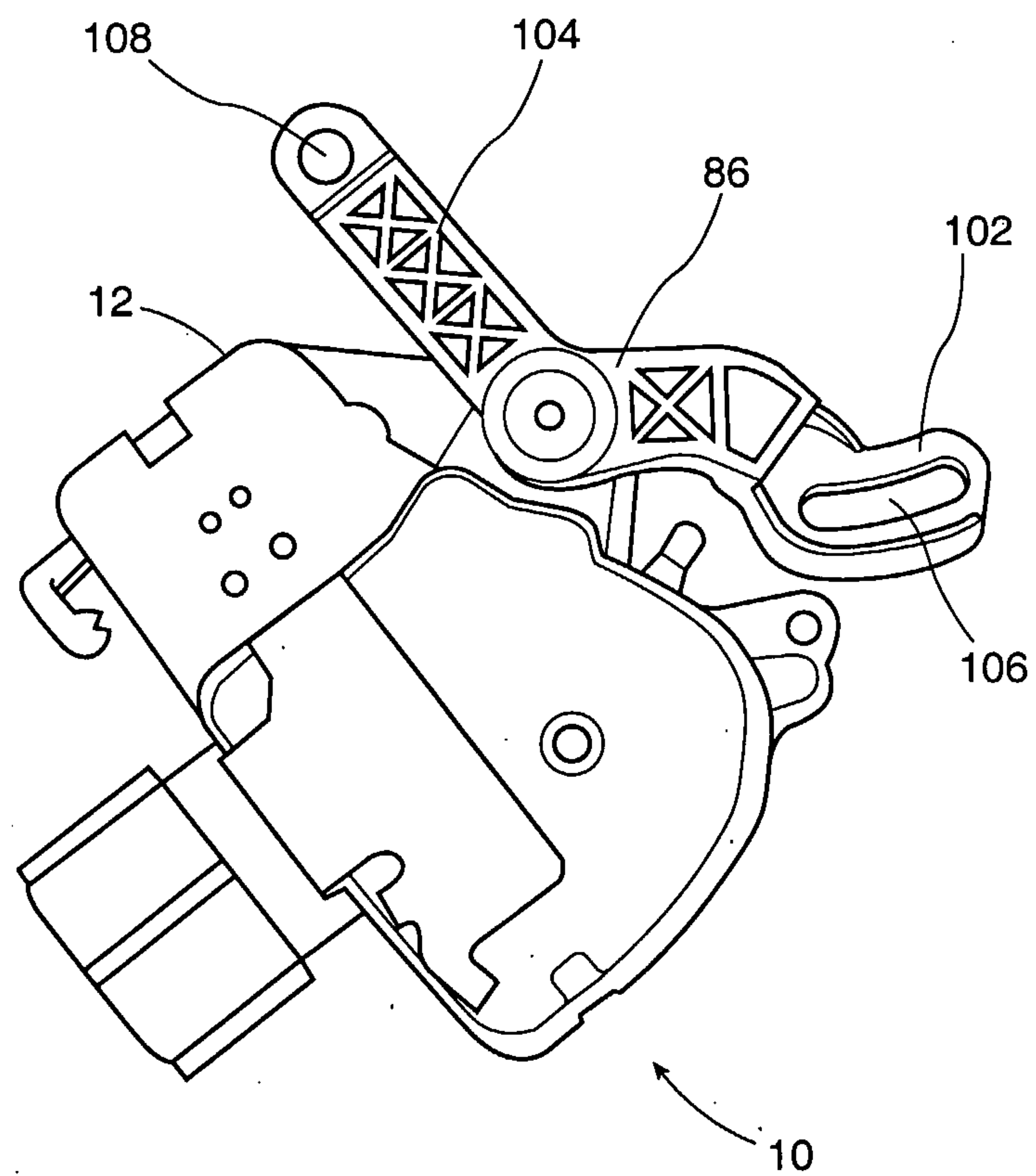
Substitute Sheet

1. A power actuator for a door latch, the power actuator comprising:
 - a reversible motor, mounted to a housing and operable to drive a worm;
 - a worm gear, rotatably mounted to the housing and driven by the worm, the worm gear being rotatable between a first and a second angular position upon actuation of the motor;
 - a spring, mounted to the housing, for urging the worm gear to a neutral position intermediate the first and second angular positions when the motor is disengaged;
 - a transfer lever, pivotally mounted to the housing and movable between a first and second positions, the transfer lever being kinematically coupled to the worm gear via a lost motion connection thereby enabling the transfer lever to be moved between the first and second position without driving the worm gear when the worm gear is in the neutral position; and
 - a toggle mechanism pivotally connected to the transfer lever and slidably mounted to the housing, the toggle mechanism operable to urge the transfer lever to the nearest of the first and second positions when the transfer lever is between the first and second positions.
2. The power actuator of claim 1, wherein the toggle mechanism includes:
 - a locking lever, the locking lever being slidably located in a slot within the housing adjacent the transfer lever, the locking lever further being pivotable between a locked and an unlocked position;
 - a locking spring interconnecting the locking lever and the transfer lever;and
 - wherein pivoting the transfer lever pivots the locking lever and the locking spring urges both the locking lever and the transfer lever towards the closest position of the first and second position when each lever has completed less than half of its pivot and towards the other of the first and second position when each lever has completed more than half of its pivot.

Substitute Sheet

3. The power actuator of claim 2, further comprising two circumferentially spaced apart lobes on the worm gear; and the transfer lever is independently movable between the two lobes.
4. The power actuator of claim 3, wherein rotating the worm gear towards one of the first and second angular positions causes one of the two lobes to kinematically engage and thereby actuate the transfer lever.
5. The power actuator of claim 2, further comprising an output lever, said output lever being actuated by the transfer lever.
6. The power actuator of claim 5, wherein the output lever is coupled to a spline located coaxially on the transfer lever.
7. The power actuator of claim 6, wherein the spline is star shaped and the output lever includes a complementary star-shaped mounting hole operable to locate the output lever on the spline.
8. The power actuator of claim 2, wherein pivoting the transfer lever between the first and second position triggers a sensor switch.

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**Figure 1**

Substitute Sheet

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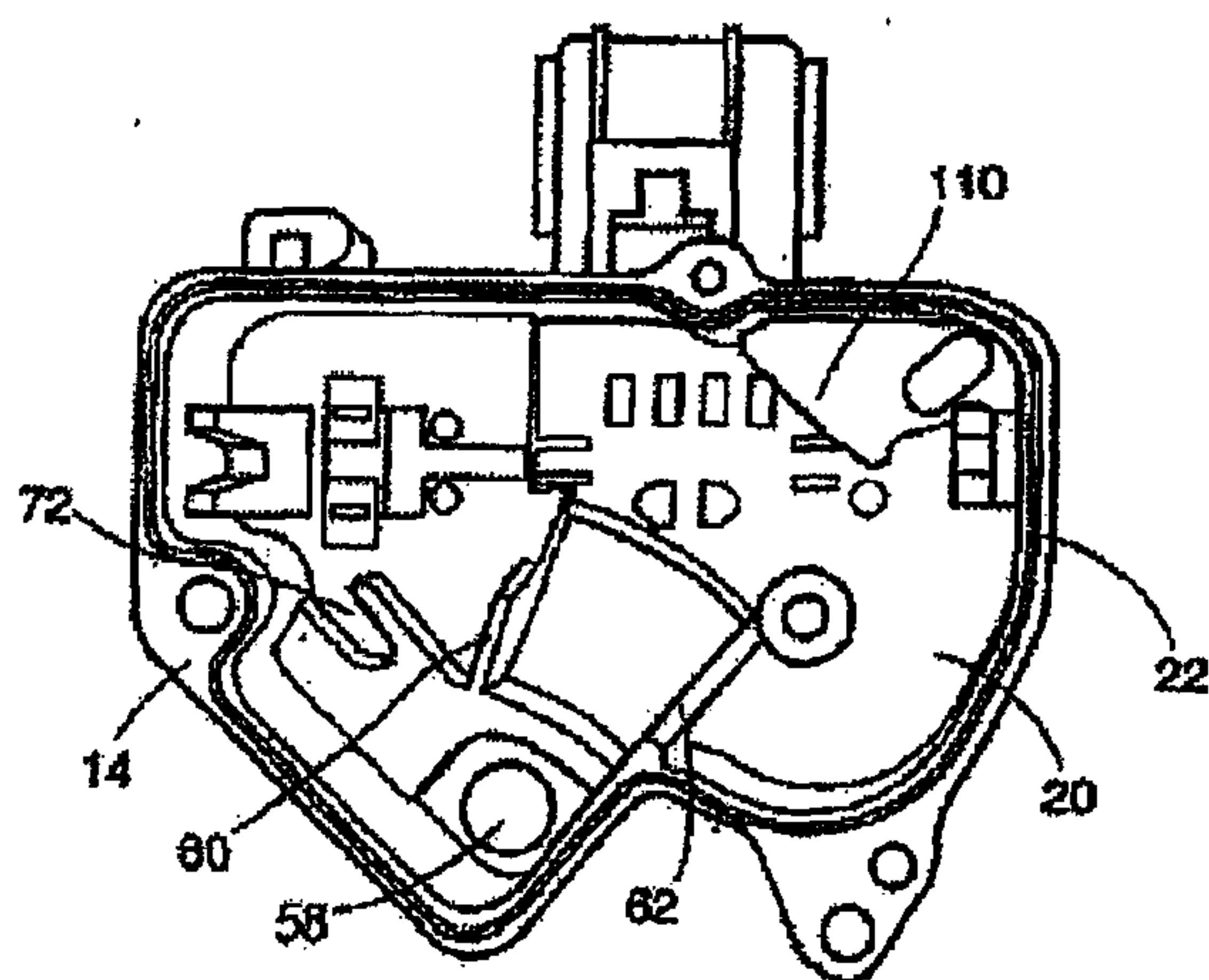


Figure 2

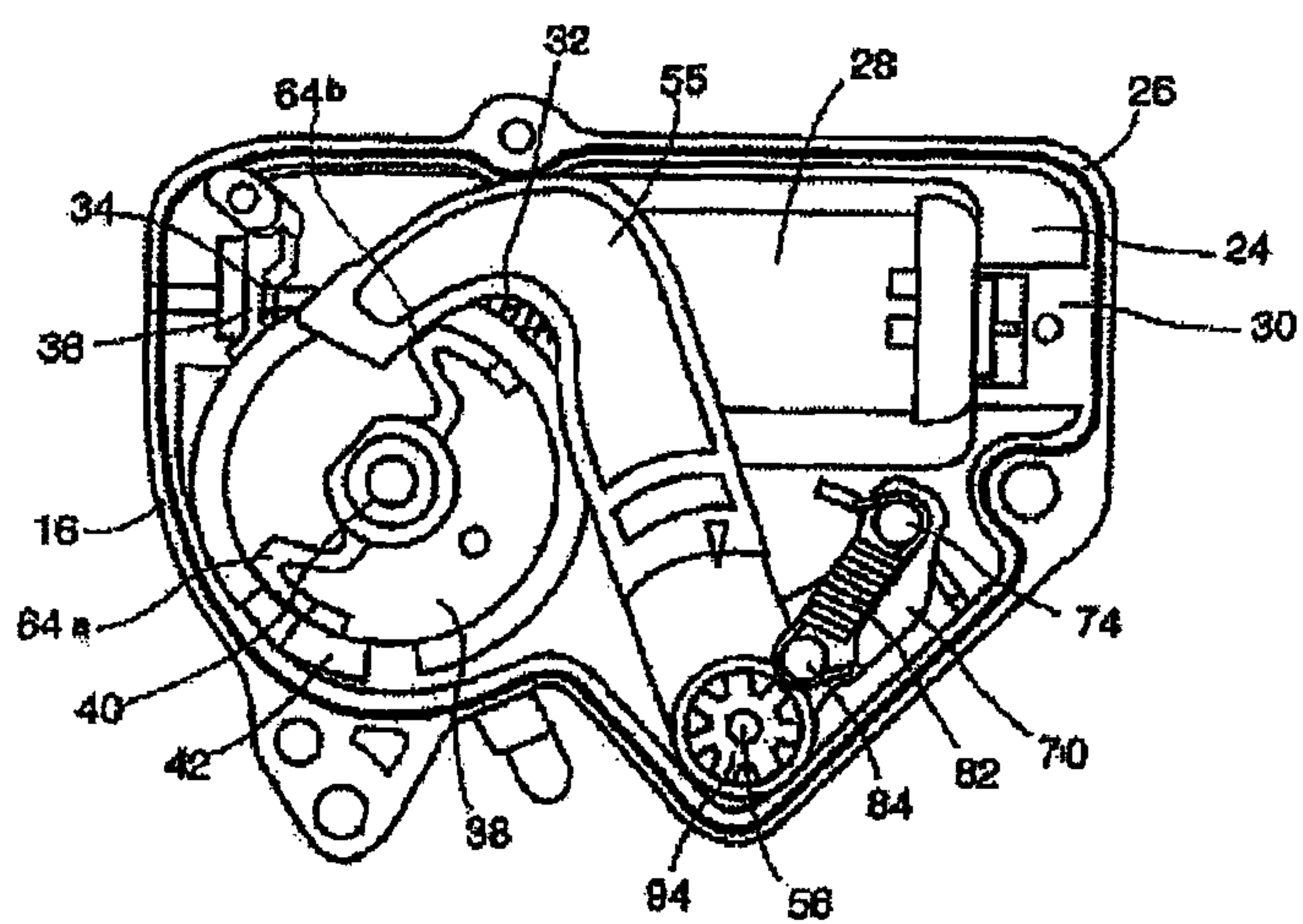
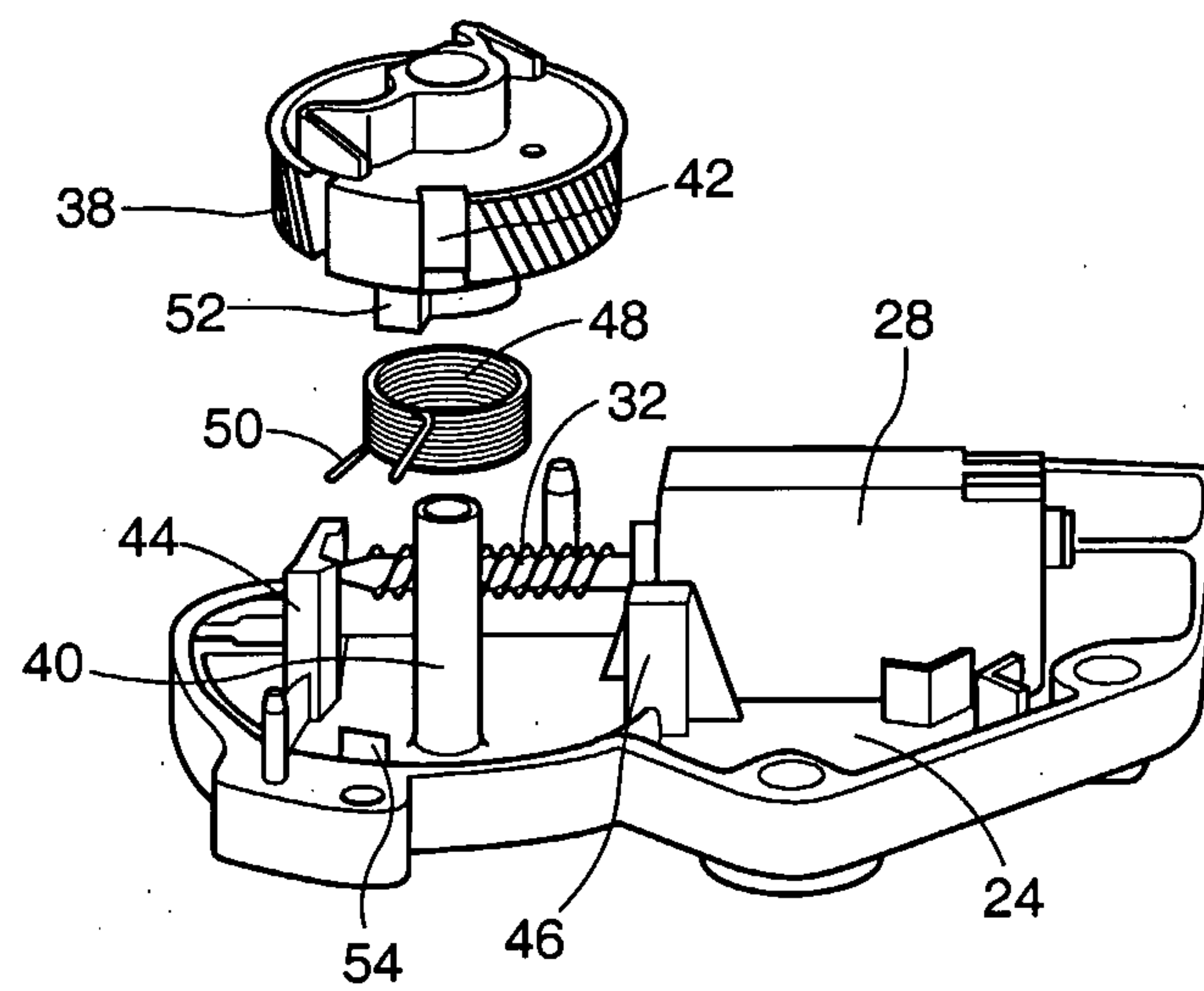


Figure 3

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**Figure 4**

Substitute Sheet

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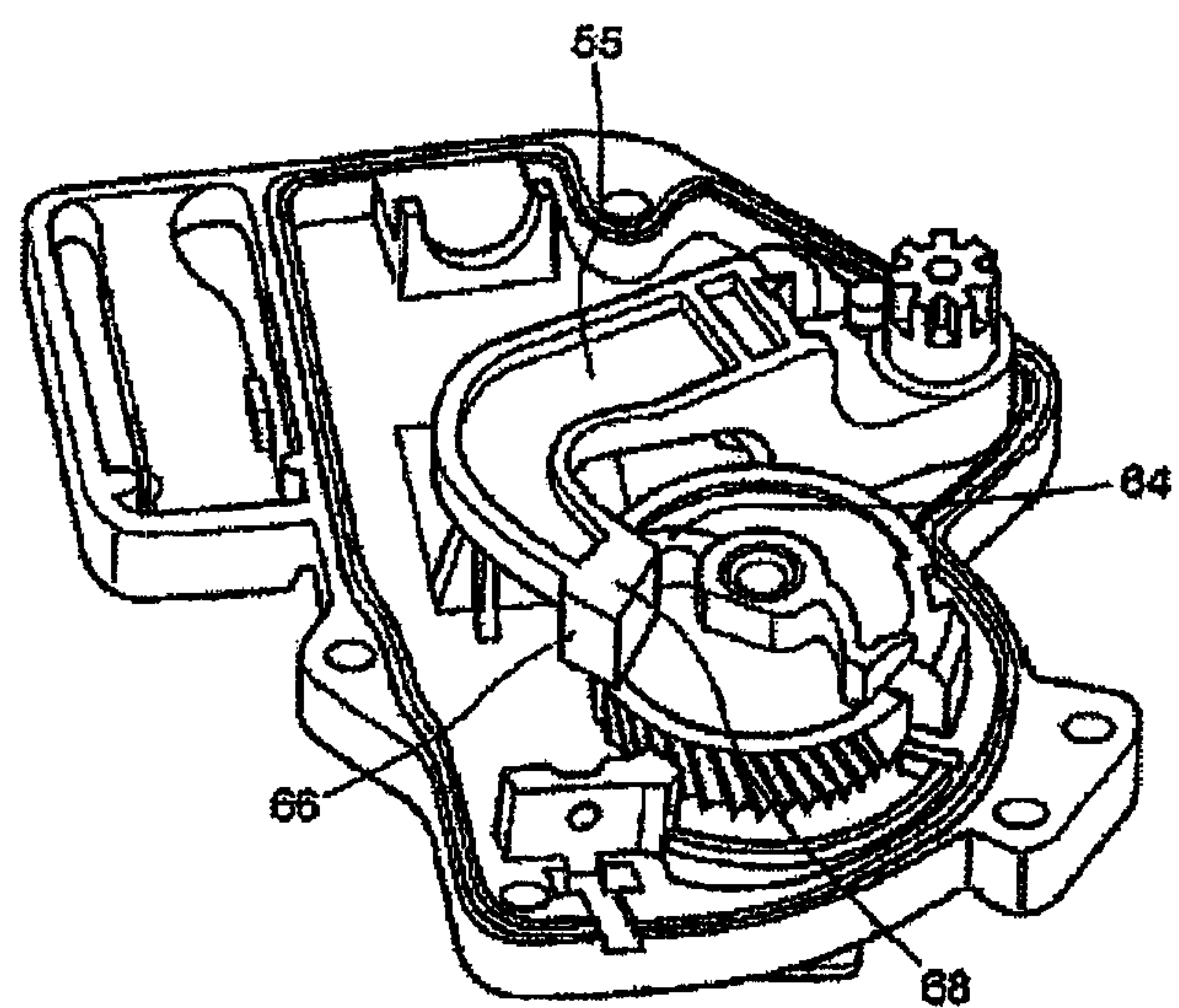


Figure 5a

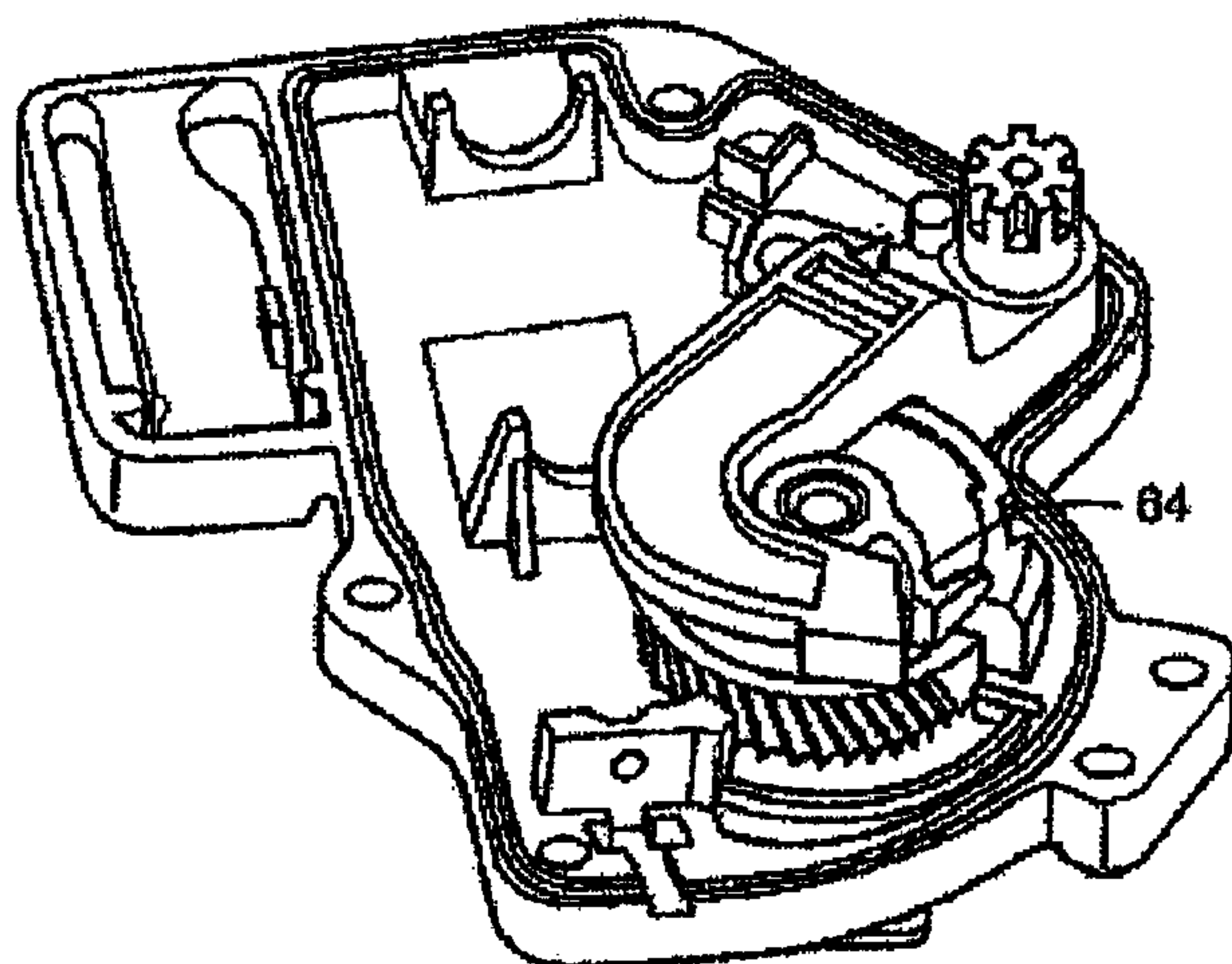


Figure 5b

Substitute Sheet

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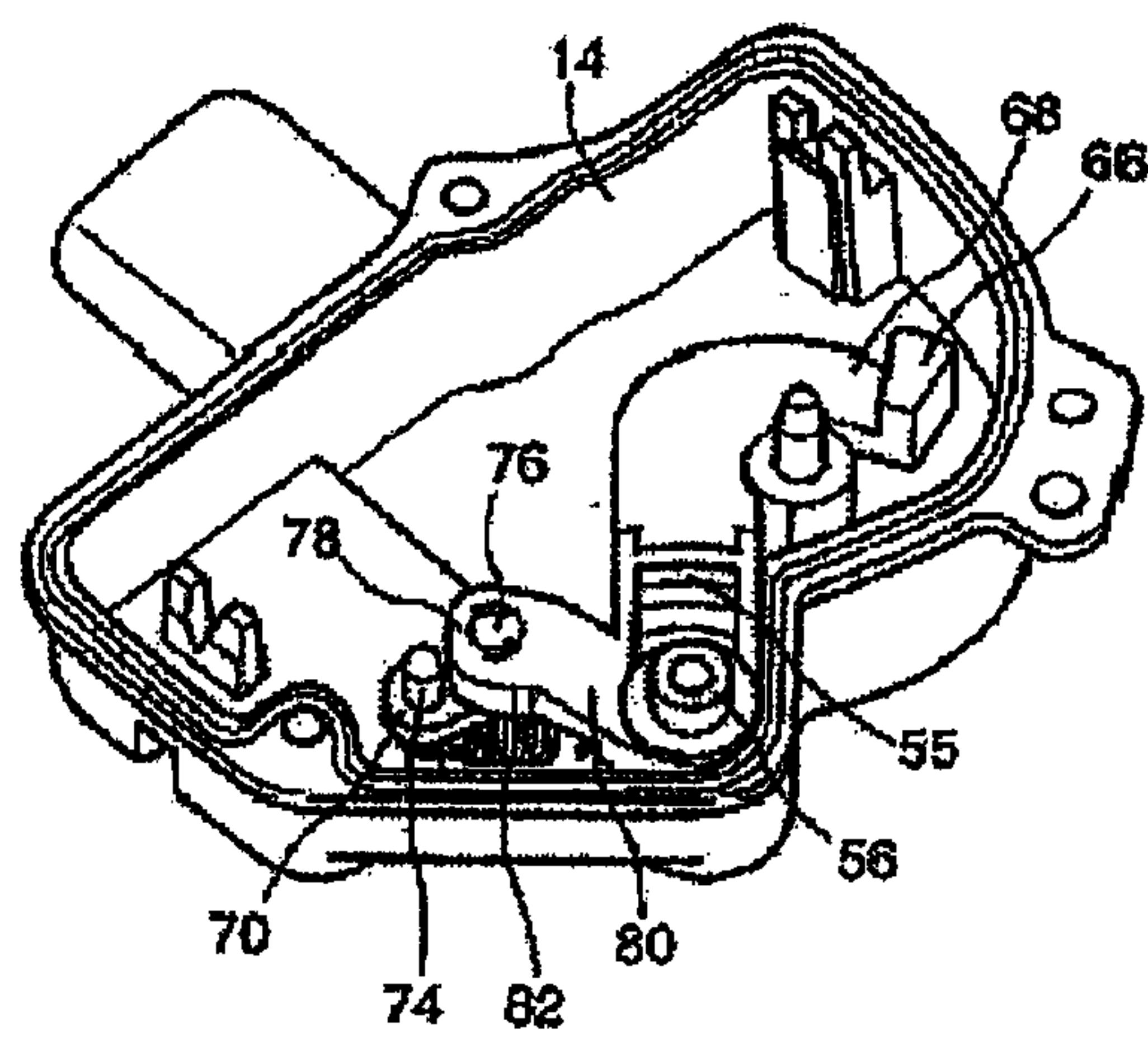
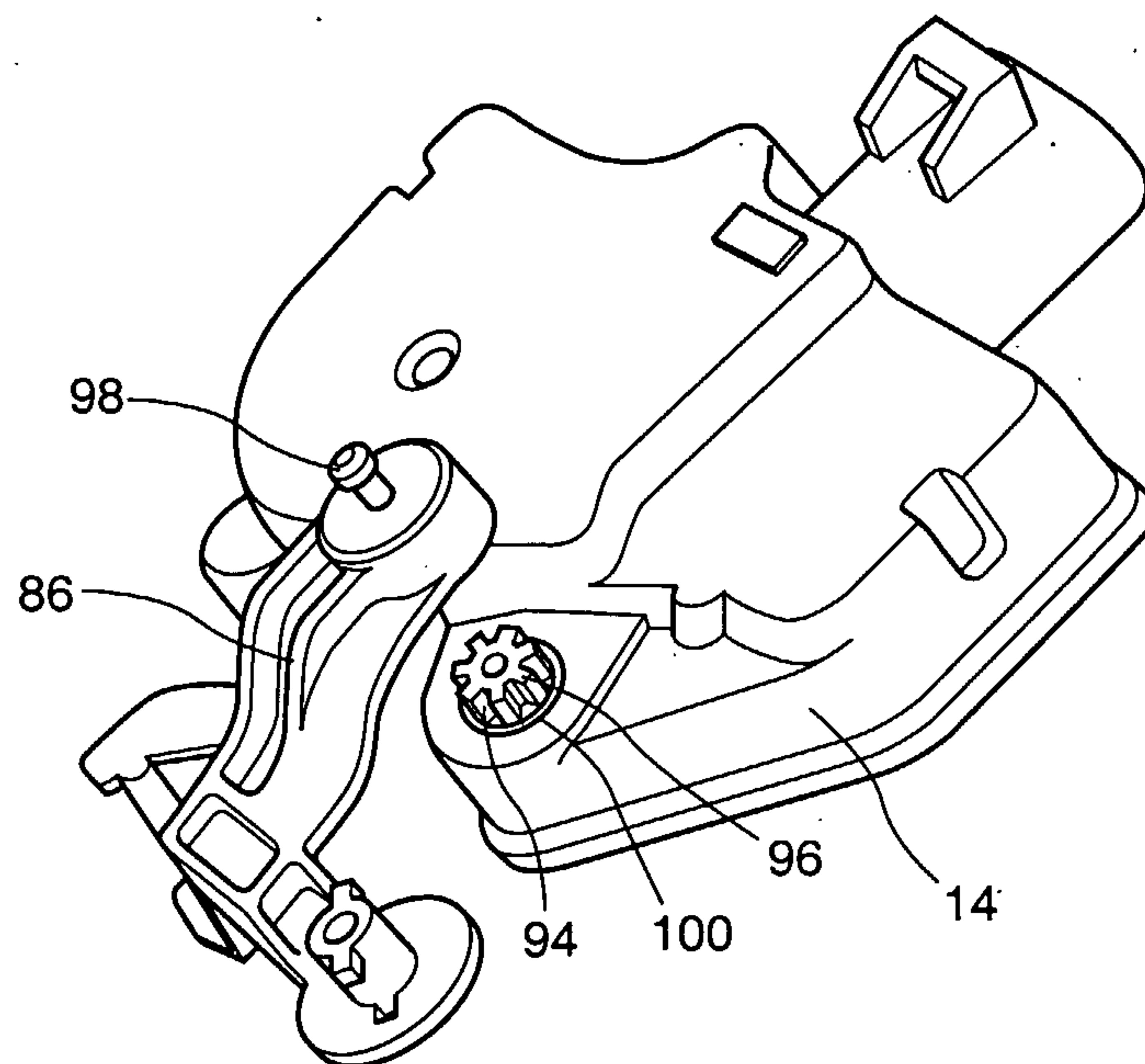


Figure 6

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**Figure 7**

